

Sustainable Solid Waste Management: An Assessment of Solid Waste Treatment in Lusaka, Zambia

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Abstract

The study conducted was an investigation of the challenges of sustainable Solid Waste Management (SWM) in Lusaka, Zambia's capital. The problem of SWM has become more complicated and requires sustainable long-term programs for its solution as less than 20% of the solid waste collected was disposed of properly. Lusaka lacked proper SWM strategies. For this study, data collection comprised of naturalistic observations at the main dumpsite in Lusaka and questionnaires to nine waste enterprises mandated to collect waste in addition to the Lusaka City Council (N = 10). The study focused on understanding the current situation of sustainable SWM, particularly the waste treatment process after disposal. Results revealed several challenges affecting an efficient sustainable waste management system, which were primarily highlighted as; lack of waste separation at source, insufficient funds and lack of equipment. All the private companies interviewed indicated that their role in SWM was basically in collection and disposal. Most private companies indicated that they were secondary waste collectors, whereas majority of the Community Based Enterprises (CBEs) were primary collectors. From the research findings, treatment of solid waste was conducted at very minimal rates and not sustainable. At the dumpsite, the machinery was out of service facilitating indiscriminate dumping rather than use of the landfill method.

Keywords: sustainable, solid waste management, landfill, treatment, dumpsite

Introduction

Globally, around 1.3 billion tons of garbage is generated each day. This translates into each city dweller generating about 1.2 kilograms daily. It is estimated that this will increase to 2.2 billion tons by 2025. Sub-Saharan Africa generates approximately 62 million tons of garbage yearly. Similarly, in developed countries, the amount of waste is rising due to the continuous increase of the population, changes in lifestyle and increasing urbanization (Hoornweg et al. 2013).

Solid Waste Management (SWM) is a major public health concern worldwide as poor management of waste not only leads to declining environmental health conditions but also contributes to disease outbreaks (Zulu 2019). This creates the challenge of how to handle waste, especially after disposal (Guerrero et al. 2013), making sustainable solid waste treatment a vital area of engagement for future city development. It is important that effective and sustainable waste management practices are developed to ensure that all generated waste is well disposed of and treated thereafter. This research thus investigated waste treatment methods in the city of Lusaka, Zambia (based in Sub-Saharan Africa) as pertaining to "what happened after" the waste was disposed of and how sustainable the treatment methods were.

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UN-Habitat (2010) highlighted that Zambia's waste generation rates were approximately 0.52 kg per person daily. While this may seem modest compared to the 1.2 kg per person generated in developed countries, most garbage in the developing world is not collected by municipal collection systems because of poor management, equipment failure, or inadequate garbage management budgets, thereby worsening waste management and sustainable disposal and treatment, such as the case of Zambia. Zambia Environmental Management Agency (2011) argues that despite the existence of a national SWM strategy, the growth of the urban population and increased economic activity had resulted in an accumulation of waste. This study is proving the validity and depth of the cited claim by doing a further investigation. Even though equipment failure and inadequate budgets was a known problem at the time of the study, the UN-Habitat statement on worsening waste management can be further investigated.

Considering that less than 20% of Lusaka's urban waste was treated after disposal, there was an inherent risk of environmental susceptibilities, due to the failure to sort waste. According to the Lusaka City Council and Environmental Council of Zambia (hereinafter referred to as the Council or LCC) (2008), Lusaka generates about 1,000 tons of solid waste daily. The challenge is that only about 300 tons of the waste is disposed of at the designated dumpsites and treated in a sustainable environmental manner (UN-Habitat 2010). Management of urban refuse in Lusaka is a responsibility of the Council through its Waste Management Unit (WMU), which is under the Public Health Services Directorate. In addition, the problem of public health intensifies during the rainy season, when outbreaks of various diseases like cholera and dysentery, are generated in most densely populated areas of Lusaka. These diseases spread and propagate because of the poor sanitary conditions (Wilson et al. 2012). Solid waste is often contaminated with human or animal excreta. Those who handle the waste, or work where the waste accumulates, will therefore often be at risk from excreta-related infections and diseases. In 2016, Zambia reported about 1,179 cases of cholera, with 31 deaths including eight children (UNICEF Zambia 2016).

The increasing solid waste generated in Zambia coupled with rapid urbanization and development of new residential areas was not accompanied by adequate sanitation facilities and management programs (Zambia Environmental Management Agency 2011), leaving the Council with less resource to spend on waste management. This paved way for the mushrooming of small and medium-sized enterprises that collected solid waste from residential areas at a fee (Lusaka City Council and Environmental Council of Zambia 2008). The Council then involved the communities in the management of solid waste by introducing Community Based Enterprises (CBEs) to control and supplement their efforts. The CBEs reach out to 30% of the city despite the tendency of citizens to not pay for the services offered. More than 30% of the population of Lusaka have waste collection through informal service providers who are not registered with the Council and therefore do not use the controlled disposal facility (UN-Habitat 2010).

Waste disposal is a critical stage in SWM as well as ensuring the waste is taken to the right disposal site. However, the most critical stage is waste treatment. Over recent years, the WMU encountered a number of problems including inadequate disposal areas and unsustainable treatment methods such as failure to correctly carry out the sanitary landfill method at dumpsites, un-managed burning and uncontrolled burying of waste; the implications of burning, such as air pollution and production of poisonous gases, cannot be ignored. The practice goes further to increase prevalence of respiratory diseases by exposing people to the dangers posed by the explosion of spray cans when exposed to fire. Uncontrolled burying of waste too, could pollute the environment. Also, poor disposal of non-biodegradable wastes like plastics could be harmful to the environment. Zhang et al. (2011) argues that the environmental pollution by plastic wastes is now recognized widely to be a major environmental burden.

According to a research conducted by Hambulo (2014), the most common method for waste treatment in Lusaka city was landfilling. This was conducted at Chunga Dumpsite. In landfilling, a layer of waste would be levelled and covered with a thin layer of soil. For burying, the aim was decomposition of waste, although this could result

into green house effect. Greenhouse effect is one problem of poor waste disposal, but contamination through improper waste disposal is also problematic. Burning of waste without incinerators created air pollution and risked fire breakouts or explosions (Kasala 2014).

Objectives of the Study

The purpose of this research was to find out how effective and sustainable the solid waste treatment methods were in Lusaka. The specific objectives were to investigate how the solid waste was disposed of and treated after collection, such as the methods of treatment used, assessment of how sustainable the current methods of treatment were and to investigate the challenges faced in treating waste.

1. Subjects and Methods

1.1. Study Design

The study adopted a qualitative design to get deeper understanding of what really goes on with solid waste treatment in Lusaka. Naturalistic observations, at the dumpsite and interviews were conducted. One-on-one Interviews were conducted with all participants. Where interviews were not possible, participants answered interview questions in questionnaire format.

1.2. Sample size

The research only covered Lusaka based enterprises involved in collection and treatment of waste (N = 10). These included the Council and nine other subcontracted companies and CBEs that were involved in waste management around the city. These nine companies were the only selected companies because they were registered with the Council and legally known companies operating in Lusaka at the time of the research.

1.3. Sampling method

The sample of participants was purposively selected due to their essential knowledge and involvement in the operations of SWM practices. The nine key respondents were drawn from the Council as these companies had been engaged by the Council to collect and dispose of waste in Lusaka. The research also targeted Lusaka's main legal and designated disposal site, Chunga Dumpsite, which was visited for observation purposes by the researcher.

The nature of social research entailed that many ethical issues be taken into consideration when conducting the study. Throughout the research, the following codes of conduct were followed: (i) informed consent was received from all respondents, (ii) participation was voluntary with freedom of withdrawal, and (iii) respondents were kept anonymous to ensure confidentiality. Collected data were only used for academic purposes.

1.4. Data collection method

The research involved the use of two different interviews; one specifically for the Council as the main body mandated to run SWM and another type for private companies. The interview guide focused on the subject of sustainable solid waste treatment methods and what the enterprises were doing about waste treatment. The open ended questions in the interview guide also enabled the respondents to express their views on the study. Collected questionnaire data was then analyzed using qualitative methods, by creating tables from the available data. For naturalistic observation, an observation guide was used at the dumpsite. Naturalistic observation techniques were used to observe the situation at the dumpsite in its natural setting and monitor the methods of solid waste treatment after disposal. Photographs were also taken of observed sites.

2. Results

The following are the results from the interviews with the ten companies. Information of naturalistic observations has also been incorporated to give context. Main findings are broken down into four sections namely; (i) Waste Collection, (ii) Waste Disposal and Uses, (iii) Solid Waste Treatment and (iv) Sustainability of SWM and Challenges Faced.

2.1. Waste Collection

The Council and the enterprises engaged in waste management in Lusaka managed the collection of waste. The table shows the company names, areas where the particular company collected waste and the waste collection category; either primary or secondary collection. The table shows the enterprises, collection areas (referred to as zones) as well as the type of waste collection they are involved in (Table 1). From the research findings, all enterprises including the Council had specific areas where waste was collected. These zones were allocated to each enterprise by the Council because it was the Council that sub-contracted them. In addition, most of these enterprises belonged to a union that protected them if conflicts arose.

There were mainly two kinds of collectors; primary or secondary collector. Secondary collection involved moving waste from the household to the dumpsite, whereas in primary collection, household waste was first moved to a container before another company collected it for disposal at the dumpsite. A map showing waste collection sites in Lusaka, Zambia has been attached (Figure 1).

Most companies indicated that they were both primary and secondary collectors. For instance, the Council, a secondary waste collector, collected waste from three zones (the central business district and two residential areas within its vicinity). Private companies like CITIMOP, also a secondary waste collector, collected waste from two groups of clients; corporate companies like hotels and the airport, and planned conventional residential areas. CBEs on the other hand, involved individuals or a group of people from the community who predominantly collected waste from unplanned settlements or areas. In addition, majority of the enterprises indicated that they collected waste from their jurisdictions once or twice a week. Enterprises that worked with corporate and/or institutions producing mass waste such as hotels collected waste on a daily basis.

2.2. Waste Disposal and Uses

It is sufficed to mention that all the secondary waste collectors interviewed stated that they all disposed of their waste at the main dumpsite. When asked if at all these companies did anything to the waste after disposal, majority of the CBEs indicated that they used the waste for other purposes, whilst the private companies indicated that they did not do anything with the waste. The majority of the CBEs highlighted that they were involved in recycling and reusing waste and also indicated that they sold the waste to manufacturing companies who made various products like egg trays, chairs, electricity pipes, plastics and other kinds of papers. Table 1 also shows the names of the enterprises, the disposal sites and the various uses of the waste after collection. The table shows the name of each enterprise, the disposal site and ways in which waste was used or handled after collection. The disposal sites varied from across enterprises depending on whether the enterprise was a primary or secondary waste collector. According to this research, a primary collector only collected waste from the households or community to a waste point or container in the community, awaiting for the Council or assigned enterprise to take the waste to the dumpsite. On the other hand, a secondary waste collector included those enterprises that collected waste to the final waste disposal dumpsite at the main dumpsite.

Table 1. Enterprises engaged in solid waste management in Lusaka.

No.	Name of Enterprise	Collection Sites	Collection Category	Disposal Site	Waste Uses
1	Lusaka City Council	Town, Thorn Park, Villa	Secondary collection	Main Dumpsite	Recycle and reuse waste
2	HW Solid Waste Management (SWM) Company	Chipata compound, Makeni, Town Central, Industrial Area	Primary and Secondary collection	Main Dumpsite	Sell papers, plastics to companies
3	CITIMOP Limited	Companies, Longacres, Northmead, Rhodes Park, Fairview, Makeni	Primary and Secondary collection	Main Dumpsite	None
4	Kutwano SWM Company	Ng'ombe Compound	Primary collection	Ngombe Compound	Reuse and recycle waste with Manja-Pamodzi initiative
5	Chinvano-Nichabwino Enterprise	George Compound	Primary collection	George Compound	Recycle plastic and paper waste
6	G.P and J Management Services	Kaunda Square Stage 2	Secondary collection	Main Dumpsite	Recycle waste
7	Amano Sewerage and Sanitary Services	Matero	Secondary collection	Main Dumpsite	None
8	Recika Company	Matero	Primary and Secondary collection	Matero and Main Dumpsite	Recycle and compost making
9	Clean Fast Limited	Marshlands, Roma, Handsworth, Kalundu, Jesmondine, Olympia	Secondary collection	Main Dumpsite	None
10	Twincare Cleaning Services	Avondale	Secondary collection	Main Dumpsite	None

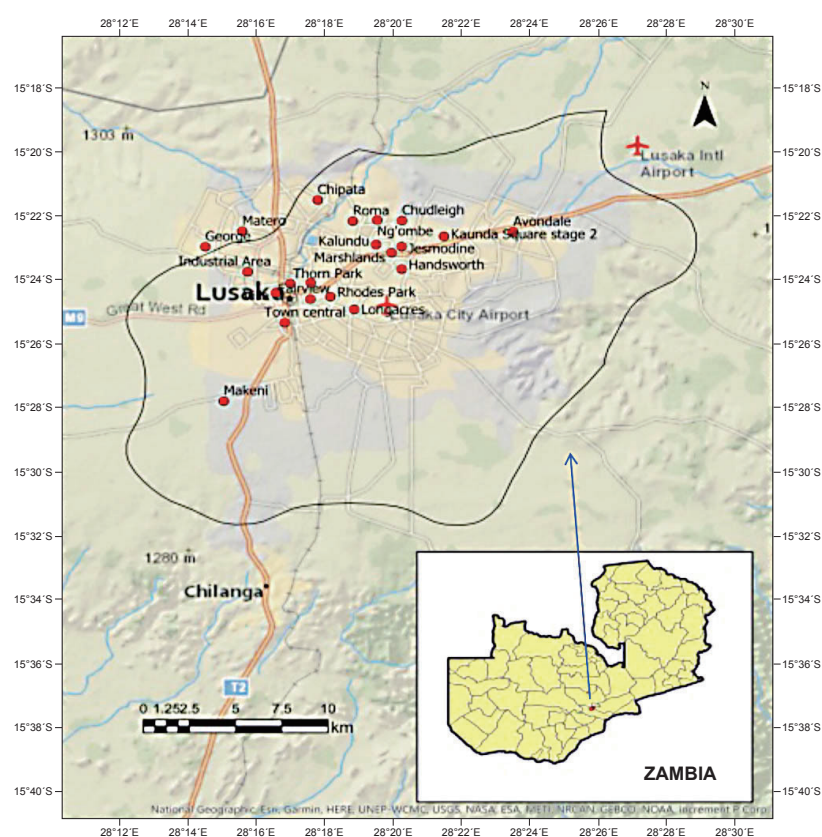
**Figure 1. Map showing waste collection sites (red dots) in Lusaka, Zambia.**



Figure 2. Crude dumping at Chunga Dumpsite (main site), Lusaka.
(Taken by the authors)

2.3. Solid Waste Treatment

Landfilling was the most common waste treatment method used by the Council. This had not been effectively carried out for the past three years due to equipment failure. As a result, the landfilling equipment that was supposed to compact the waste by covering it with soil to prevent breeding insects and other dangerous diseases, and reduce the area occupied by waste could not function. Burning was also another treatment method carried out at the dumpsite using incineration. There was a fairly big, traditional incinerator at the site where expired goods, chemicals or harmful substances were burnt down. Incineration was usually for goods that were considered harmful to the society. The Zambia Bureau of Standards and other relevant authorities took up the mandate to incinerate such goods so that they were not sold to the public or consumed by the people at the site. The treatment methods were controlled and conducted only by the Council and other standards regulatory bodies like Zambia Environmental Management Agency (ZEMA). Figure 2 shows crude dumping at the dumpsite, with little or no landfill method of waste treatment as observed at the site. At the time of the research, there were only two machines managing the Chunga Dumpsite whilst the main waste compacter had been down for over three years.

2.4. Solid Waste Management and Challenges Faced

This segment was only answered by the Council. As regards to the extent to which the treatment methods used were effective, the Council stated that the landfill method was the best waste treatment method. By design, the Chunga Dumpsite was built to last for 25 years on the same piece of land, provided that the necessary equipment and personnel were available to conduct the landfill activity effectively. However, with the observed mode of waste disposal and equipment failure, the facility was not expected to last up to the stated years of capacity. The site had been transformed from a landfill to an indiscriminate dumping site. In the 13th year of operation, the dumpsite was almost full. On the other hand, incineration was found to be more long lasting, permanent, durable and sustainable because waste was completely reduced and burnt to ashes. Also, dangerous products could be reduced completely without toxic gases released because waste products were burnt down at very high temperatures. As a result, less or no land was occupied as compared to the landfill method. Even with this, the site only had one incinerator.

2.5. The Conditions of Waste Pickers and workers at the Site

Members of the public who worked at the site searching for useful materials in order to earn a living were very easy to spot. Both the adult waste pickers and children faced more constant occupational risks and injuries



Figure 3. Poor sanitary conditions for workers and waste pickers, Chunga Dumpsite.
(Taken by the authors)

while working at the dumpsite. Figure 3 shows the poor sanitary conditions for workers and waste pickers at the dumpsite. The workers included; the Council workers and the waste collectors who transported the waste. For the most part, the Council officers worked in very poor health and hygiene conditions. Even though there were some measures in place to protect their health, they were only given milk to drink, whilst their bodies were still exposed to diseases and other harmful substances without any protective gear.

3. Discussion

3.1. Waste Collection

The Council stated that its role was to ensure the city's cleanliness through proper SWM at all levels; household, corporate and commercial. According to the Japanese Ministry of the Environment (2014), municipalities were responsible for properly managing waste in areas under their respective jurisdictions and implementation of measures to construct, improve and maintain waste management facilities. The Council's role was to supervise waste management activities and conduct routine inspections of both private enterprises and CBEs, and ensure that the laws and by-laws on illegal waste management were enforced and adhered to.

The majority of the private enterprises indicated that their role was primarily in collection and disposal of waste as either secondary or primary collectors. Secondary collection involved moving waste to the final dumpsite while primary did not. The Council indicated that its collection of waste was an ongoing process by routine (regular collection points) and on-call, in cases where waste might have been dumped poorly, illegally or was not managed as per regulation and standards (Kalembe 2014). The Council was to ensure the smooth running of SWM operations.

3.2. Waste Disposal and Uses

From the observations, the dumpsite in Lusaka was not fully utilized due to a poor waste disposal system of merely indiscriminate disposal and piling up of waste without undertaking landfill method which was the sole purpose of the main dumpsite. Edema et al. (2012) highlights that only a fraction of the solid waste generated in urban areas was collected and disposed of at the designated sites. The remaining uncollected waste was left on the streets, roadsides and drainages, resulting in the outbreak of cholera and other diseases and contributing to the general deteriorating of the environment, which has become an urgent issue in Zambia.



Figure 4. Female waste picker carrying disposed waste for recycling.
(Taken by the authors)

A private company, CITIMOP enterprises, indicated that though they were only into waste disposal services, they were considering engaging in recycling and reuse of waste in future. On the other hand, a company called HW SWM enterprises highlighted that they supplied various companies waste for reuse and recycling, like cart boxes and plastic materials. However, HW SWM indicated that it was an expensive venture to engage in recycling waste due to resources and time spent on waste sorting, with the money obtained being insufficient to cover costs (Sakala and Moyo 2017). According to the Japanese Ministry of the Environment (2014), all stakeholders must come on board. Japan placed the responsibility for sorted waste disposal on consumers, collection on municipalities, and recycling on business operators; requiring these three entities to work together to promote the recycling of waste. The Council indicated that it was involved in recycling and reuse of waste, having worked with an inventory of recycling companies for over 10 years. Figure 4 shows a female waste picker carrying disposed waste for recycling.

The dumpsite was normally crowded by waste pickers and scavengers because waste collection had become a growing business due to recycling. Emerging recycling companies in Lusaka's industrial area usually bought plastic materials for their trade (Mengo 2018). Madekivi (2017) also argues that some companies in Lusaka have implemented waste separation systems to take care of their corporate social responsibility; though the system is not yet ideal, recycling of waste has increased.

3.3. Solid Waste Treatment

All the private companies and CBEs indicated that the treatment of solid waste was entirely the responsibility of LCC, as their role in waste management ended at the disposal phase. The Council accepted responsibility of waste treatment and indicated that waste treatment would be a much easier process to undertake if there was waste sorting and separation at the source, particularly household level. According to the Ministry of the Environment (2014) consumers generating waste are responsible for promoting waste recycling by using recycled products and for reducing waste disposal or sorting waste to be disposed of, thereby cooperating with national and local governments in their efforts to reduce and properly manage waste. Japan's main strategies focused on waste reduction at source and recycling, with the complements of incineration and landfills, in order to build a recycling-based society. Measures implemented were draft laws like implementing mandatory household waste classification recycling and building thermal waste treatment facilities that turn waste into energy. Results obtained were that solid waste disposal rate decreased from 10.5 million tons in 2000 to 5.07 million tons in 2009.

However, in Zambia, waste separation only occurred at about 20% as most of the sorting for reuse and recycling



Figure 5. Proximity of households to the Chunga Dumpsite (approx. 25 m radius).
(Taken by the authors)

was done at the Chunga Dumpsite. Treatment of unsorted waste was very difficult to conduct, greatly reducing its effects. In addition, poor utilization of the dumpsite also resulted from lack of machinery and insufficient funds to run the landfill to its maximum potential. Burying and burning of waste was not also conducted. The Ministry of the Environment (2014) emphasized developing a new system that included consumers and manufacturers for minimizing the total amount of waste by promoting recycling.

Madekivi (2017) argues that most recycling in Lusaka is done after disposal, mainly by waste collectors in unplanned settlements and waste pickers at the landfill who collected from unsorted waste. Dumpsites were found to lack security measures. The site was not properly fortified and protected from unauthorized persons. The wall fence surrounding the dumpsite lay in ruins with very few Council police to control entrance into the facility. Illegal scavengers, who usually invaded the site looking for what to pick, reuse or sell to companies and/or communities were often seen at the site (Silimina 2019). With challenges by the Council to control the facility and regulate those who entered, it continued to be vandalized and had become a good breeding ground for diseases and infections that spread from the dumpsite to surrounding communities (Figure 5). Figure 5 shows proximity of households to the Chunga Dumpsite.

Despite control measures through registration of persons accessing the area, it seemed there was very little adherence from the community members as some would use other means of entering to access the waste, e.g., jumping over the wall fence. One could still argue however, that even the registration procedure was not effective when one compared the number of people who were registered to access the place and the number of people seen in the facility.

Despite all these challenges, it was solely the duty of the Council to treat waste. It is important to note that the Council had taken up the role to encourage and educate the public in environmental and sustainable SWM through burying organic or degradable waste. Making of organic compost was mostly done at household level, though at low rates.

3.4. Solid Waste Management and Challenges Faced

There were various challenges that the Council encountered as it endeavored to sustainably treat waste at the dumpsite. Firstly, the inability for some members of the public to pay for waste management services forcing the Council and enterprises to operate on minimal to no funds for staff, machinery, maintenance and transportation. Illegal collection and dumping of waste was a challenge too. There was a tendency by illegal waste collectors to collect waste from people and dump it in areas that were not approved for waste disposal, creating financial burden

for the Council that was responsible for the city's waste management, including collection of poorly disposed waste. Being unregistered, it was difficult for the Council to make claims over poorly disposed waste or recover funds collected by illegal collectors, further hampering the Council's work.

The monitoring of enterprises subcontracted to assist in SWM in regards to the rate of Lusaka's growth and expansion was also a challenge. Solid waste areas are grouped into zones and districts referred to as catchments. It is through the smaller segments called catchments that the Council monitors the collection, disposal and management of waste. However, some areas, especially unplanned settlements, tend to be vast and over populated making effective monitoring a huge problem for the Council.

Lastly, there was a lack of enough trucks for waste collection. The lack of transport also hindered the effectiveness of the Council in conducting inspections of subcontracted enterprises. According to Edema et al (2012), limited resources in terms of money, skilled manpower and logistics make it very difficult to handle the bulk volume of solid waste being generated, creating an enormous challenge for institutions charged with SWM.

3.5. Recommendations

Firstly, waste treatment would be a much easier process to undertake if there was waste sorting and separation at the source, particularly the household. This can be achieved by the introduction of plastic bags or containers clearly stating the kind of waste that should be in a particular container. Secondly, the government, Council and all other stakeholders need to ensure that the intended purpose of the dumpsite is fulfilled. New machinery and frequent maintenance thereof is required. Also educating people on policies and enforcing laws governing garbage disposal, especially those concerned with collection, transportation and disposing of garbage should be coupled with stiffer punishments and charges. Thirdly, Government should introduce a subject on SWM and its impacts on the environment in both primary and secondary schools focused on the benefits of sustainable solid waste treatment and waste sorting from source (homes, offices and schools). Lastly, the Council and its stakeholders must attach the solid waste collection fee to other public fees such as water or electricity. This would ensure that no one escapes paying waste management fees and reduce on waste collection from illegal collectors.

Conclusion

From the findings of the study, treatment of solid waste was done at a very minimal rate. Observations from Chunga Dumpsite revealed that landfill machinery was non-operational, facilitating crude dumping rather than use of the landfill method. The dumpsite was originally projected to last for about 25 years, but observation indicated it was almost up to capacity in its 13th year. The problems that affected an efficient waste management system in the city of Lusaka had been highlighted on three main issues: the lack of ways to increase more sustainable waste treatment methods in place due to no waste separation at source, insufficient funds and lack of equipment to undertake the landfill method on site.

The shortage of equipment has been to a larger extent due to lack of vehicle standardization. Inappropriate refuse collection vehicles and the poor revenue collection system by the LCC have also contributed to the deterioration of services in the entire management of the city's refuse. The government and the Council indicated intention to repair or buy new machinery for landfill purposes. Finally, lack of political will also contributed significantly to the worsening situation of waste management in Lusaka. Less financial attention was given to the waste management sector, and as a result, the dumpsite was no longer treating waste as expected. This study went beyond these claims by having close observations, engaging contracted companies and researching on how waste is actually handled. Also, this manuscript is going to be among very few literatures available on SWM in Zambia.

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References

- Edema, M. O., Sichamba, V. and Ntengwe, V. W. 2012. Solid Waste Management-Case study of Ndola, Zambia. *International Journal of Plant, Animal and Environmental Sciences* 2(3): 248–255. https://www.academia.edu/30874341/SOLID_WASTE_MANAGEMENT-CASE_STUDY_OF_NDOLA_ZAMBIA
- Guerrero, L. A., Maas, G. and Hogland, W. 2013. Solid waste management challenges for cities in developing countries. *Waste Management* 33(1): 220–232. <https://doi.org/10.1016/j.wasman.2012.09.008>
- Hambulo, C. 2014. 'Stakeholders' participation in solid waste management in selected Zambian urban primary schools of Lusaka, Zambia. Master's dissertation, Education in Environmental Education, The University of Zambia.
- Hoornweg, D., Bada-Tata, P. and Kennedy, C. 2013. Environment: Waste Production Must Peak this Century. *Nature* 502(7473): 615–617. <https://doi.org/10.1038/502615a>
- Kalembe, S. 2014. Let's just comply. *Zambia Daily Mail*. Posted at September 14, 2014. Online. <http://www.daily-mail.co.zm/lets-just-comply/> (Accessed November 27, 2019)
- Kasala, S. E. 2014. Critical analysis of the challenges of solid waste management initiatives in Keko Machungwa informal settlement, Daressalaam. *Journal of Environmental Protection* 5(12): 1054–1074. <https://doi.org/10.4236/jep.2014.512105>
- Lusaka City Council and Environmental Council of Zambia 2008. *Lusaka City State of Environment Outlook Report*. Lusaka City Council and Environmental Council of Zambia, Lusaka. Online. <https://wedocs.unep.org/bitstream/handle/20.500.11822/9062/-/%20Lusaka%20City%20State%20of%20Environment%20%28SoE%29%20Outlook%20report%20-2008Lusaka%20City%20State%20of%20Environment%20%28SoE%29%20Outlook%20report.pdf?sequence=3&isAllowed=y> (Accessed July 28, 2020)
- Madekivi, T. 2017. *Effectiveness of recycling initiatives in the city of Lusaka, Zambia: Case of Ng'ombe compound*. Bachelor's thesis, Industrial Management and Engineering, Turku University of Applied Sciences. Online. <https://www.theseus.fi/bitstream/handle/10024/131729/Effectiveness-of-Recycling-Initiatives-in-the-City-of-Lusaka-05.06.2017.pdf?sequence=1&isAllowed=y> (Accessed November 30, 2019)
- Mengo, V. 2018. Booming waste scavenging business, its perils. *Zambia Daily Mail*. Posted at April 25, 2018. Online. <http://www.daily-mail.co.zm/booming-waste-scavenging-business-its-perils/> (Accessed November 29, 2019)
- Ministry of the Environment 2014. *History and current state of waste management in Japan*. Ministry of the Environment, Tokyo. Online. http://www.env.go.jp/recycle/circul/venous_industry/en/history.pdf (Accessed November 23, 2019)
- Sakala, W. D and Moyo, S. 2017. Solid waste recycling and job market in Zambia. *Sustainable Resources Management Journal* 2(6): 1–9. <https://doi.org/10.5281/zenodo.846712>
- Silimina, D. 2019. *Case Study: Chinese recycling firm creates jobs while cleaning up Lusaka*. The China-Africa Project. Posted at August 22, 2019. Online. <https://chinaafricaproject.com/analysis/chinese-recycling-firm-creates-jobs-while-cleaning-up-lusaka/> (Accessed November 28, 2019)
- UN-Habitat (United Nations Human Settlements Programme) 2010. *Solid Waste management in the Worlds Cities: Water and Sanitation in the Worlds Cities*. Earthscan Limited press, London.
- UNICEF Zambia 2016. *Zambia, Cholera Outbreak Report*. Online. <https://reliefweb.int/report/zambia/zambia->

cholera-outbreak-unicef-situation-report-5-9-may-2016 (Accessed October 20, 2017)

- Wilson, D. C., Rodic, L., Scheinberg, A., Velis, C. A. and Alabaster, G. 2012. Comparative analysis of solid waste management in 20 cities. *Waste Management & Research* 30(3): 237–254. <https://doi.org/10.1177/0734242X12437569>
- Zambia Environmental Management Agency 2011. *The Enviro-Line*. Longman, Lusaka.
- Zhang, X., Luo, X., Liu H., Yu, L., Chen, S. and Mai, B. 2011. Bioaccumulation of several brominated flame retardants and dechlorane plus in water birds from an e-waste recycling region in South China: Associated with trophic level and diet sources. *Environmental Science & Technology* 45(2): 400–405. <https://doi.org/10.1021/es102251s>
- Zulu, A. 2019. Assessment of Solid Waste Management in Residential Townships in Lusaka Zambia. *Acta Scientific Agriculture* 3(11): 62–66. <https://doi.org/10.31080/ASAG.2019.03.0685>